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Users' Manual and Validation of the Automated Grading System (AGS)

Improving the Quality of Intelligence Summaries Using Feedback from an Unsupervised Model of Semantics

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Defence R&D Canada
Technical Memorandum
DRDC Toronto TM 2012-060
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In conducting the research described in this report, the investigators adhered to the policies and procedures set out in the Tri-Council Policy Statement: Ethical conduct for research involving humans, National Council on Ethics in Human Research, Ottawa, 1998 as issued jointly by the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council of Canada and the Social Sciences and Humanities Research Council of Canada.

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Abstract

The Automated Grading System (AGS) was developed jointly by Defence Research and Development Canada (DRDC) Toronto and the Canadian Forces School of Military Intelligence (CFSMI) to provide students at the school a tool to help in the composition of accurate and effective Intelligence Summaries (INTSUMs). The AGS is a web-browse based system that provides feedback to students about how well their summary matches that of a gold standard summary written by an instructor. The AGS allows students to iteratively correct and re-submit their summaries as they attempt to maximize the match between their summary and the gold standard. In this report, we provide both the instructor and student user's manual for the AGS. Importantly, we also provide the results of a small validation study wherein we asked participants to summarize news stories about sea piracy near Somalia. Participants used feedback from the AGS to improve their summaries until they were satisfied that they had done the best job they could do. The grades given to the first and final summaries by the AGS were then compared to the grades awarded by the lead instructor at CFSMI. The tool and the instructor's assessments of the summaries were in close agreement. The results confirm that the AGS can be used as an effective teaching tool to help students improve their summary-writing skills.

Résumé

Le système automatique de notation (AGS) a été développé en collaboration avec Recherche et développement pour la défense Canada (RDDC), à Toronto, et l'École du renseignement militaire des Forces canadiennes (ERMFC) dans le but d'aider les élèves à rédiger des résumés renseignement (INTSUM) efficaces et précis. Il s'agit d'un logiciel Web permettant aux élèves de savoir dans quelle mesure leurs résumés correspondent au modèle idéal composé par un instructeur. L'AGS leur permet de modifier itérativement leurs textes et de les faire analyser de nouveau pour maximiser la correspondance. Ce rapport comprend un manuel d'utilisateur pour les instructeurs et les élèves. Il présente également les résultats d'une petite étude de validation durant laquelle les participants ont résumé des reportages sur la piraterie en mer près de la Somalie. Ils ont utilisé la rétroaction de l'AGS pour retravailler leurs compositions jusqu'à ce qu'ils jugent avoir fait de leur mieux. Les notes attribuées par le logiciel pour les premiers et derniers résumés ont été comparées à celles données par l'instructeur principal de l'ERMFC, et le tout concordait. Cela confirme que l'AGS est un outil pédagogique efficace pouvant aider les élèves à améliorer leur capacité à rédiger des résumés.

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Executive summary

Users' Manual and Validation of the Automated Grading System (AGS): Improving the Quality of Intelligence Summaries Using Feedback from an Unsupervised Model of Semantics

Peter Kwantes; Ron Wulf; Benjamin Stone; DRDC Toronto TM 2012-0602012-060; Defence R&D Canada – Toronto; December 2012.

Introduction or background: Intelligence analysts must be able to write clear, concise and accurate intelligence summaries. As with most skills, effective summarization skills must be learned. The Automated Grading System (AGS) is a computer program that assigns a grade and provides basic feedback to intelligence summaries written by students learning the skill. Briefly, the computer program compares the semantic content of a student's summary of source documents to a "gold standard" summary. If the summary and gold standard are similar enough, the student receives a passing grade. Otherwise, the student "fails" and is invited to attempt to improve his or her summary and resubmit. In this report, we validated the AGS by having undergraduates at Ohio State University write a summary of news articles on the topic of marine piracy. Students used the AGS to improve their summaries, and submitted their final version when they were satisfied with its quality. The students' first-written and final summaries were then given to the lead analyst/instructor at the Canadian Forces School of Military Intelligence (CFSMI) for grading. The validation involved the instructor grading the two summaries provided by each student.

Results: In general, the grades assigned to the summaries by the AGS agreed with those provided by the instructor. Importantly, however, the AGS and instructor had high agreement on the amount with which summaries improved with practice. Put simply, the AGS was an effective tool for improving the quality of participants' summaries.

Significance: This validation study demonstrated that the AGS could be used by training and educational organizations within the CF as a tool for helping students improve certain aspects of their writing ability. In particular, the educational context for the intelligence domain can benefit from using the AGS to help students learn effective intelligence summary writing. Perhaps equally important, the AGS may preclude the need to train effective writers in class. Rather, because the program is browser-based and installed on a network, students can practice summary writing in their own time outside of class.

Future plans: The AGS' intended user (and co-developer) was the CFSMI. Our intention is to have the program installed at the school so that students can start using it immediately. The usefulness of the AGS likely reaches beyond just the intelligence realm. Anyone required to learn effective reporting could potentially benefit from using the AGS. We see other potential users that include the Royal Military College of Canada (RMCC), Canadian Defence Academy (CDA) and the Influence Activities Task Force (IATF)

Sommaire

Validation of the Automated Grading System (AGS): Improving the Quality of Intelligence Summaries Using Feedback from an Unsupervised Model of Semantics

Peter Kwantes; Ron Wulf; Benjamin Stone ; DRDC Toronto TM 2012-0602012-060 ; R & D pour la défense Canada – Toronto; décembre 2012.

Introduction ou contexte : Les analystes du renseignement doivent être capable de rédiger des résumés renseignement clairs, concis et précis. Comme pour toute compétence, il faut apprendre à résumer de manière efficace. Le système automatique de notation (AGS) est un logiciel donnant une note et une rétroaction de base aux textes des élèves en apprentissage. En bref, le programme compare le contenu sémantique du résumé d'un élève à celui d'un modèle « idéal ». Lorsque le contenu est semblable, l'élève obtient une note de passage. Par contre, s'il « échoue », il peut retravailler sa composition avant de la faire analyser de nouveau. La participation d'étudiants de premier cycle de l'université de l'Ohio a permis de valider l'AGS. Après avoir résumé des articles sur la piraterie en mer, les participants ont utilisé le logiciel afin d'améliorer leurs textes et de présenter la version définitive une fois qu'ils sont satisfaits de la qualité. Les premières et dernières versions des résumés ont ensuite été remises à l'analyste/instructeur principal de l'École du renseignement militaire des Forces canadiennes (ERMFC) pour qu'il les note. Dans le cadre du processus de validation, il a attribué des notes aux deux résumés de tous les étudiants.

Résultats : Dans l'ensemble, les notes données par l'AGS concordaient avec celles de l'instructeur. Il faut noter que le niveau de concordance était élevé en ce qui a trait au degré d'amélioration des résumés résultant de la pratique. En termes simples, l'AGS est un outil efficace permettant d'augmenter la qualité des compositions des participants.

Importance : Cette étude de validation démontre que des organisations d'enseignement et d'instruction des FC pourraient utiliser l'AGS comme outil pour aider les élèves à améliorer certains aspects de leur capacité de rédaction. Le contexte éducatif du domaine du renseignement pourrait tout particulièrement profiter du logiciel pour enseigner la rédaction de résumés renseignement efficaces. En outre, l'AGS pourrait écarter la nécessité de former des rédacteurs en classe. Puisqu'il s'agit d'un logiciel Web installé sur un réseau, les élèves peuvent s'exercer à rédiger des résumés en dehors de la classe.

Perspectives : L'AGS a été conçu pour l'ERMFC (qui a collaboré au développement). L'objectif est d'installer le logiciel à l'école afin que les élèves puissent l'utiliser immédiatement. Il est probable que l'utilité de l'AGS aille au-delà du domaine du renseignement. Tous les élèves apprenant à rédiger des rapports efficaces pourraient profiter de cet outil. Le Collège militaire royal du Canada (CMRC), l'Académie canadienne de la Défense et la force opérationnelle chargée des activités d'influence (FO AI) font partie des utilisateurs potentiels.

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1 Introduction

1.1 Summarization as an Intelligence Operator's role

Part of the job of an intelligence analyst, is to synthesize the content of several documents or reports into a single, concise document that gets passed up to the chain of command to an intelligence consumer. Clearly, it is very important for the document, called an intelligence summary (or INTSUM) to be accurate and contain all the necessary details. The ability to produce high quality summaries however, is a skill requiring practice, and as yet, the Canadian Forces has no time-effective means by which to teach the skill within the training and educational contexts. In response, personnel from Defence Research and Development Canada – Toronto (DRDC - Toronto) and the Canadian Forces School of Military Intelligence (CFSMI) collaborated to develop a software tool called the Automated Grading System (AGS) that allows students to practice and improve INTSUM writing without the need for instructor involvement.

The AGS is a browser-based application with which a student reads a set of documents, writes a summary and submits to it the system for grading. The AGS provides the students with a set of grades, each of which indicates the extent to which certain key pieces of information are missing from their summaries .The grade assignment process is fairly simple, and described in greater detail in the next section below. Briefly however, a computational model of semantics is trained on a large collection of documents to build "meaning" representations for the words it has encountered in the collection. These word representations are used as a basis for creating a semantic representation for a "gold standard" summary document written by the AGS administrator or, which will most often be the case, an instructor. When a student submits a summary to the AGS, a semantic representation of it is created and compared to that of the gold standard. If the similarity between the two does not exceed some threshold set by the administrator, the student fails and is encouraged to improve the summary and re-submit it.

1.2 Purpose and Organization of this Report

The AGS is described in detail in the following section. Following the description, we describe a validation study in which we tested the AGS's efficacy in improving INTSUMs using university undergraduates as participants. To foreshadow the results of the study, the AGS is an effective tool for improving INTSUM composition, and it is our goal to have the AGS installed within CFSMI so that it can be used by students as part of their training program.

2 The Automated Grading System (AGS)

2.1 Detailed Description and Manual of the AGS for Administrators

In this document the words "instructor" and "admin user" are used interchangeably to describe the admin user. The Automated Grading System uses Semantic Models that generate estimates of similarity for pairs of documents. In this way, the AGS can compare and mark student summaries against a "Gold Standard" summary written by an instructor. The instructor can also include several other, smaller gold standard documents (which we refer to as nuggets) that represent particular pieces of information that must be present in a passable summary. The semantic models need to be trained on a document set or corpus that contains the background knowledge for a given summary topic. This background knowledge is required so that the AGS can make accurate comparisons between the student and instructor summaries given a certain topic and provide immediate feedback to the student user. As an administrator user of the AGS, system requirements are minimal. The AGS is a web based application that works well with the major web browsers: Internet Explorer (v.7), Firefox (2.0.0.6) and Opera (9.10). The AGS system requires that both JavaScript and pop-ups be allowed for the AGS website on the admin user's web browser.

2.1.1 Semantic Models Contained in the AGS System

As mentioned in the previous section, the AGS creates semantic representations for the INTSUMs generated by students, and compares them to a gold standard document. The psychological and computational science literatures have produced several models for extracting semantic content from unformatted text in an unsupervised fashion. Roughly speaking, regardless of the underlying algorithm, the models work on the notion that words which are semantically related will tend to occur in similar contexts, or documents. The models are trained on large document collections (perhaps in the 10's of thousands of documents) and, from its discovery of what words do occur in the same contexts/documents in the training corpus, makes educated guesses about words should occur together.

The models available to the AGS are listed below along with an article reference to allow interested readers to learn more about the models.

1) Vector Space Model (*Vectorspace*, [1])

2) Latent Semantic Analysis (*LSA*, [2])

3) Topics model (*Topics*, [3])

4) Sparse Non-negative matrix factorization (*SpNMF*, [4])

5) Independent Components Analysis (*ICA*, [5])

6) Sparse ICA (*SICA*, [6])

7) Syntagmatic Paradigmatic model (*SP*, [7])

8) Constructed Semantics Model (*CSM*, Kwantes, 2005)

The AGS uses LSA by default to create semantic representations for the gold standard documents and student summaries. LSA generates vector representations for words. The vectors corresponding to the words in a document are summed to create a vector representation for a document. Once formed into vectors, the match between the two is measured by calculating the vector cosine between the vectors for each. A vector cosine is much like a correlation coefficient in that a cosine of 1.0 indicates that two vectors have identical trajectories in space, and are therefore very highly similar, and a cosine of 0 indicates that the two vectors are unrelated. The vector of a good summary therefore, will have a much higher cosine with the gold standard documents than a poor summary.

2.1.2 Getting Started with the AGS System

2.1.2.1 Logging in

As an admin user of the AGS system you will have already been supplied with a username and password. To log into the AGS system enter your email address and password into the login box on the left-hand side of the AGS login screen (see Figure 1).

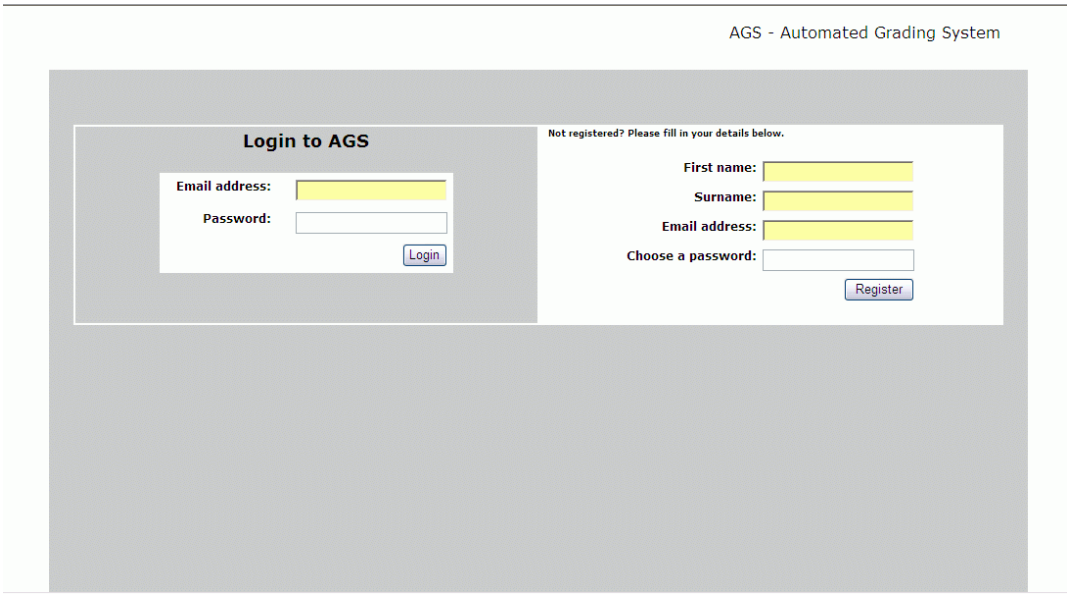

Figure 1 AGS login page.

2.1.2.2 Finding Your Way Around

As an admin user of the AGS system you have access to the Assignments, Corpora, Documents, Admin, and Help Sections of the AGS. These sections are accessed by clicking on the tabs at the top of the user interface (Figure 2). These sections will be described below in more detail. To logout of the AGS at any time, click the "logout" link located underneath the AGS logo on the top right of the page.

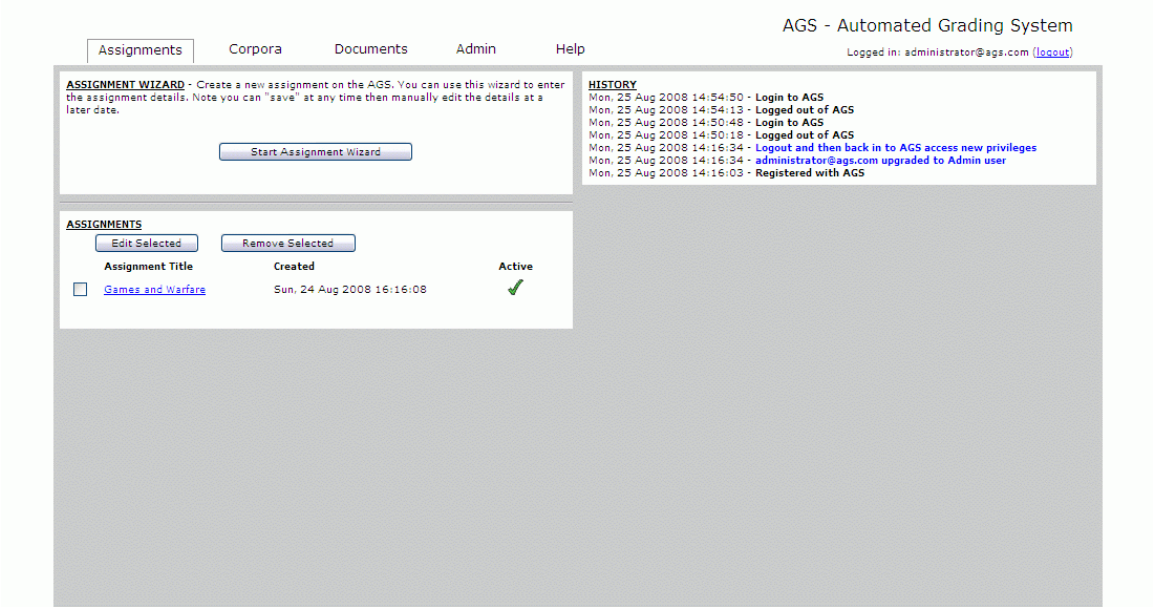

Figure 2 AGS administrator user interface (Assignments Page)

2.1.2.3 Anatomy of an Assignment

AGS assignments are composed of four major components:

1) A **corpus** or knowledge base, a set of documents which act as background knowledge for a particular assignment topic. The effectiveness of the AGS's ability to automatically grade student assignment is completely dependent on a good match between this corpus and the domain of knowledge needed to accurately access the similarity between **Student Summaries** and **"Gold Standard" summaries** provided by the Instructor.

2) **User Documents** are documents that are supplied by the instructor to the Student User to read and summarize.

3) **Instructor Documents or "Gold Standard" Summaries** are the material that student user's summaries are compared against – they are the "Gold Standard" on which the AGS will judge the student user summaries. That is, the AGS will compare Instructor documents with Student Summaries and grade these documents similarity with a mark between 0 and 1 (0 representing NO similarity, 1 a perfect match).

4) **Student Summaries** of the User Documents that are submitted to the AGS system by the Student User.

2.1.2.4 Assignment Prerequisites

Before creating an assignment using the "Assignment Wizard" (see Assignments section below), the instructor needs to load both the User Documents and Instructor Documents onto the AGS (in some cases these will be the same document). Also, if a corpus file or knowledge base has not already been loaded onto the AGS system, then instructor will need to load an assignment specific corpus onto the AGS and create a Space using the AGS tools described below.

2.1.3 Corpora

A corpus is a set of documents that provide the background or knowledge base for the Semantic Models on a given topics. For example, if the instructor wanted students to summarise "User Documents" that focused on fishing, then a good corpus would contain documents about the various types of fishing, tackle, fish, and so on. The AGS assumes that the corpus will be provided as an ASCII file containing a set of documents each separated by a blank line.

2.1.3.1 Loading Corpora

Click on the "Corpora" tab of the main menu to see Corpora page displayed in Figure 3. In the top-left box labeled "ADD CORPORA" click the "Browse" button to locate on your computer the corpus that you wish to upload to the AGS. Choose whether you would like to make the corpus Public or Private (other admin users will not be able to access Private Corpora) and add a description of the corpus as this may help you identify the corpus at a later date. Finally, click "Upload" to move the corpus from your computer onto the AGS system. This may take a long time depending on the speed of the network and the size of the corpus. After your corpus has finished uploading to the AGS system it will be displayed in the bottom-left box labeled "Available Corpora" on the Corpora page. To use the newly added corpus, it first needs to be compiled into a "Space" (see section below) *Note: The AGS assumes that the corpus will be provided as an ASCII file containing a set of documents each separated by a blank line.*

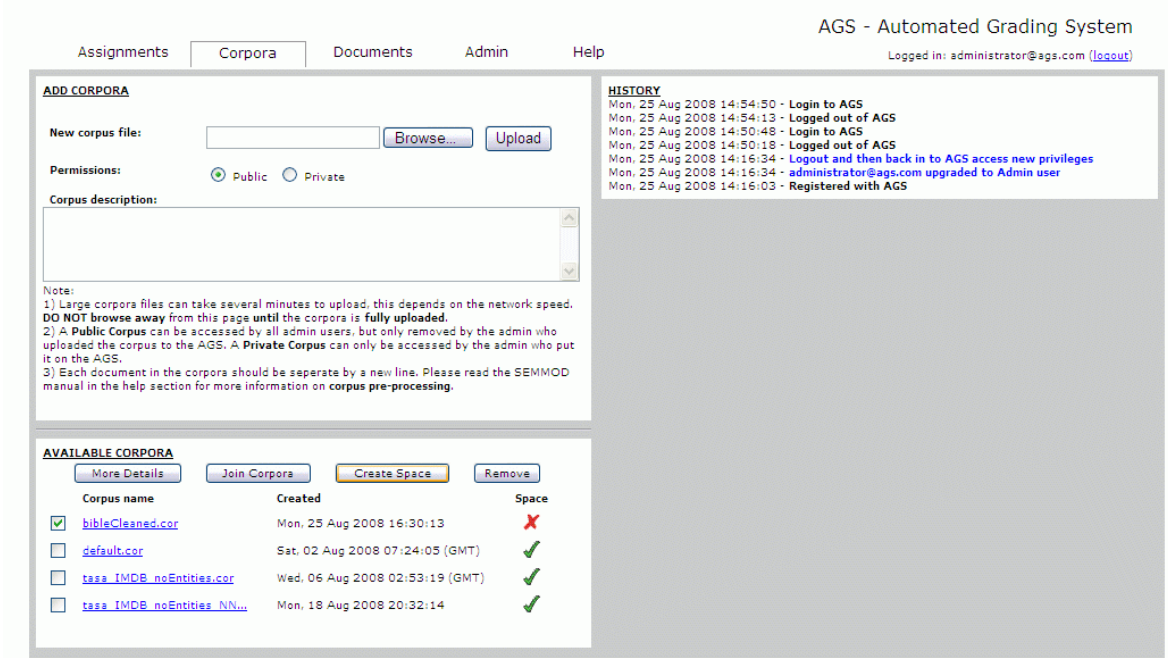

Figure 3 AGS Corpora

2.1.3.2 Compiling a Corpus into a "Knowledge Space"

Corpus files that have been added to the AGS by instructors must be compiled into a "Space" before they can be used in any assignments. To compile a corpus into a Space, select the check-box located before the corpus filename displayed in the "AVAILABLE CORPORA" list. Next, click the "Create Space" button, and choose the semantic model and define the parameters that you want to use when compiling the Space. The AGS system defaults to Latent Semantic Analysis (LSA), however you may choice between several models for your Space. To choose a different model, use the drop-down menu labeled "Change model…" (see Figure 4). Either, accept the default parameters supplied for your chosen model or enter new values as required.

Note. When dimensionality is a parameter for a model, the specified number of dimensions or topics needs to be equal to or less than the number of documents contained in a given corpus. If this requirement is not met, an error message will be displayed in the History Section (right hand panel of the display) outlining the need to fulfill this requirement.

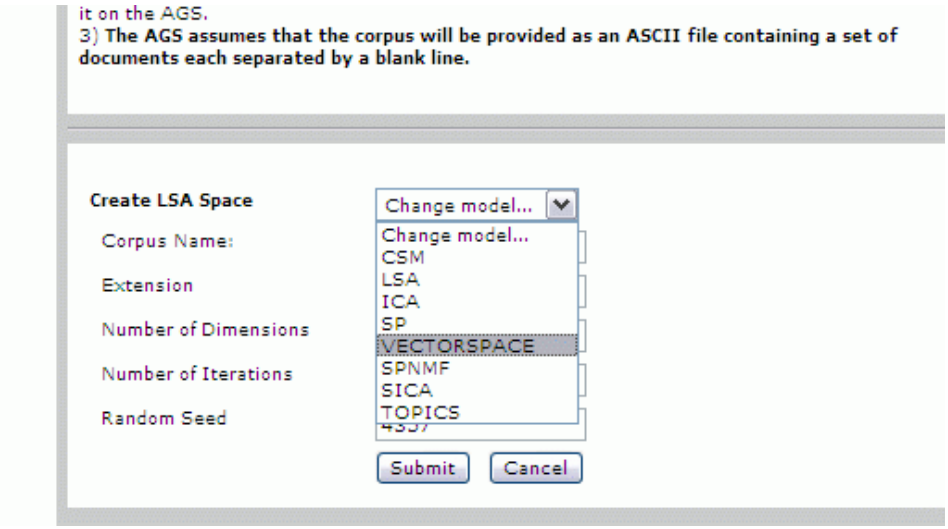

Figure 4 Choose a semantic model from the drop-down menu.

For example, if LSA is chosen by the Instructor, a box entitled, "Create LSA Space" will appear, in this box enter details such as the number of dimension, number of iterations and random seed to use when compiling the space (see Figure 5). If you are unsure what to enter, use the default settings, remembering however that the number of dimensions needs to less than or equal to the number of documents contained in the corpus. After filling in these parameters for the "Space", click "Submit". The compilation of a "Space" can take a long time, depending on the size of the corpus. For example, for a medium size corpus (approximately 40,000 documents) allow up to half an hour. After the successful compilation of the "Space" a tick will appear after the corpus filename in the column labelled "Space", this indicates that this "Space" can be used in an assignment.

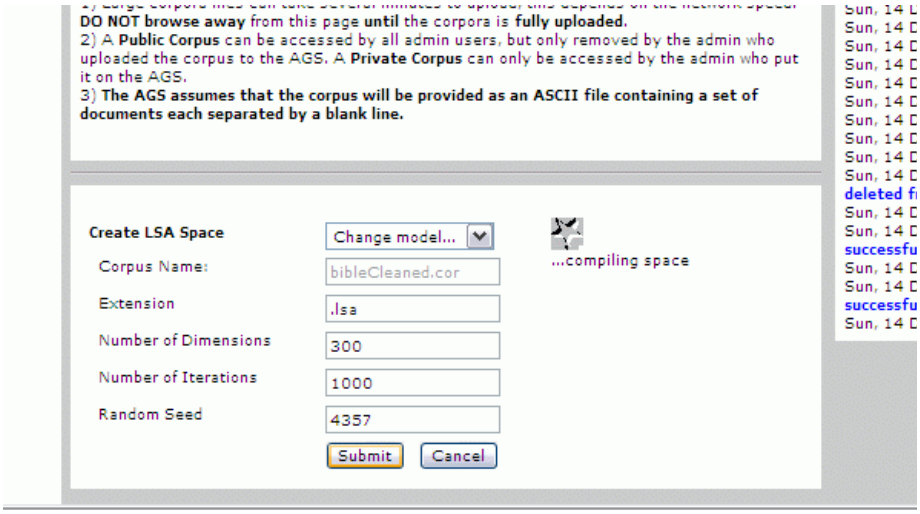

Figure 5 Enter model parameters or use the default values that are supplied.

2.1.3.3 Corpora and Space Details

Details about individual Corpus files and Spaces can be displayed (replacing the History area) to the instructor in the right panel of the Corpora page by checking the tick box next to a corpus' name and clicking on the "More Details" button (see Figure 6). If more than one Space has been compiled for an individual corpus file, the details of each Space can be accessed using the drop-down menu supplied in "Space Details" section (see Figure 6). If no Space has been compiled, only the Corpus file details will be displayed.

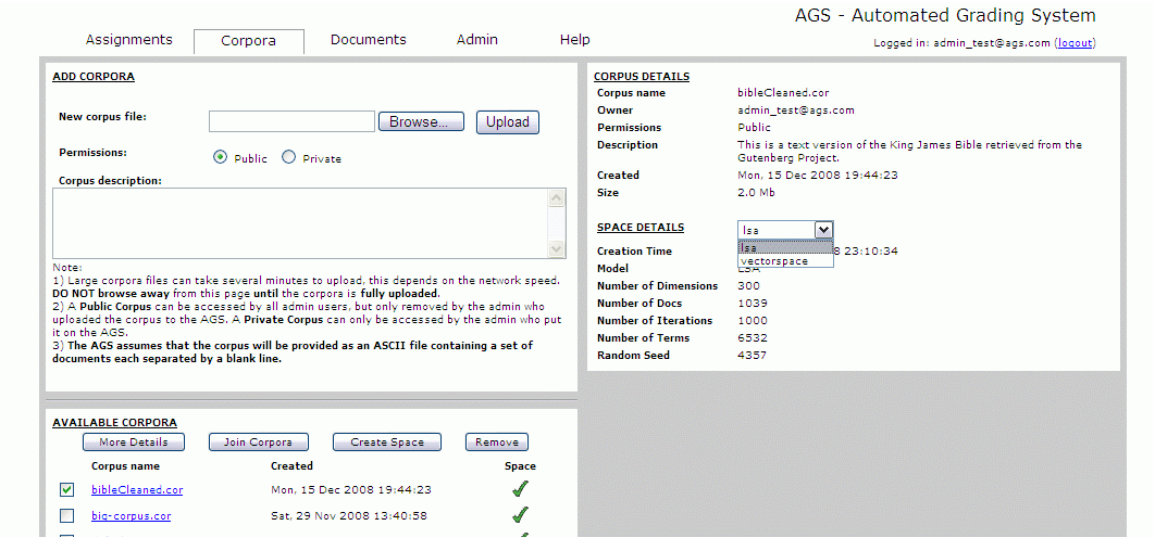

Figure 6 Creating a new assignment with the Assignment Wizard 9

2.1.3.4 Joining Existing Corpora

Existing corpora may be concatenated by checking the tick boxes next to two corpus names clicking on the "Join Corpora" button in the "AVAILABLE CORPORA" section. The instructor will then be prompted to supply a name for the new corpus. After the corpora are joined, the newly created file will be listed in the "AVAILABLE CORPORA" section.

Note: This action will not join existing Spaces which have been compiled, only the corpora. A Space will need to be compiled for the newly joined corpora.

2.1.3.5 Removing Corpora and Spaces

BE WARNED: Checking the tick box next to a corpus name in the "AVAILABLE CORPORA" section and then clicking "Remove" will remove both the corpus file AND any Spaces that have

been compiled using this corpus file! This action can only be made by the instructor if they are the owner of the corpus file. Furthermore, this action cannot be reversed by the instructor.

2.1.4 Documents

There are two types of document that the Instructor needs to load onto the AGS system: User Documents and Instructor Documents.

User Documents are documents that are supplied by the instructor to the Student User to read and summarize. Student Users accessing your assignment will be presented with these User Documents.

Instructor Documents or "Gold Standard" Summaries are the material that student user's summaries are compared against – they are the "Gold Standard" on which the AGS will judge the student user summaries. That is, the AGS will compare Instructor documents with Student Summaries and grade these documents similarity with a mark between 0 and 1 (0 representing NO similarity, 1 a perfect match).

2.1.4.1 Loading Documents

Both User Documents and Instructor Documents are loaded to the AGS in the "Documents" section of the AGS. Click on the "Documents" tab of the main menu to see Document page displayed in Figure 7. In the top-left box labeled "ADD DOCUMENT" click the "Browse" button to locate the document that you wish to upload to the AGS. Choose whether you would like to make the document Public or Private (Note: User Documents must be made Public) and add a description of the document as this may help you identify the document at a later date. Finally, click "Upload" to move the document from your computer onto the AGS system. After your document has finished uploading to the AGS system it will be displayed in the bottom-left box labeled "Available Documents" on the Documents page.

Note: All documents must be contained in an ASCII file, the AGS can not process documents in that are in proprietary formats such as .doc or .pdf

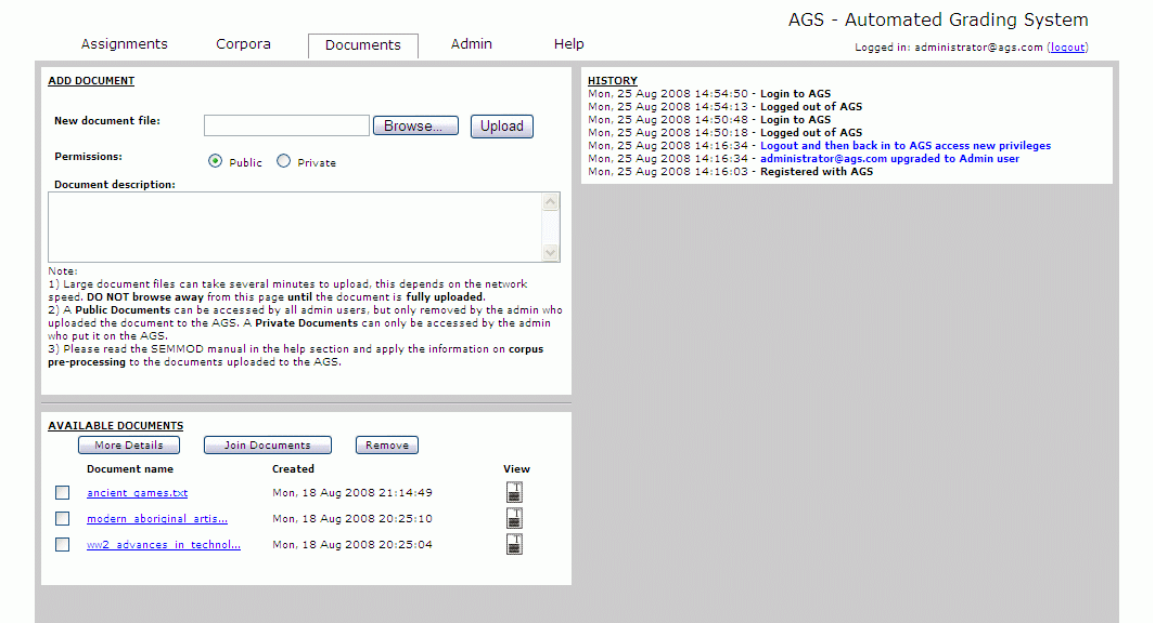

Figure 7 AGS Documents

2.1.4.2 Document Details

Details such as ownership, instructor defined description, number of unique words, total number of words, permissions (Public or Private), and file creation date can be displayed to the instructor. This information is accessed by checking the tick next the relevant document and clicking “More Details” in the “AVAILABLE DOCUMENTS” section. This document’s details will then be displayed in the right panel of the screen, replacing the History data. The full text contained in a document can be viewed by clicking on the file icon aligned with the file of interest; this is located under the “View” label in the “AVAILABLE DOCUMENTS” section. The document will then be displayed in the right panel of the screen (see Figure 7).

2.1.4.3 Joining Documents

Two documents can be concatenated by checking the tick boxes next to the files of interest and then clicking on the “Join Documents” button in the “AVAILABLE DOCUMENTS” section. The instructor will then be prompted for a new filename for the newly joined documents. After the join process is complete, the newly joined document file will be displayed in the “AVAILABLE DOCUMENTS” section.

2.1.4.4 Removing Documents

Documents can be removed from the AGS system by checking the tick box next to their filename in the "AVAILABLE DOCUMENTS" section, and then clicking on the "Remove" button. Only one document can be removed at a time.

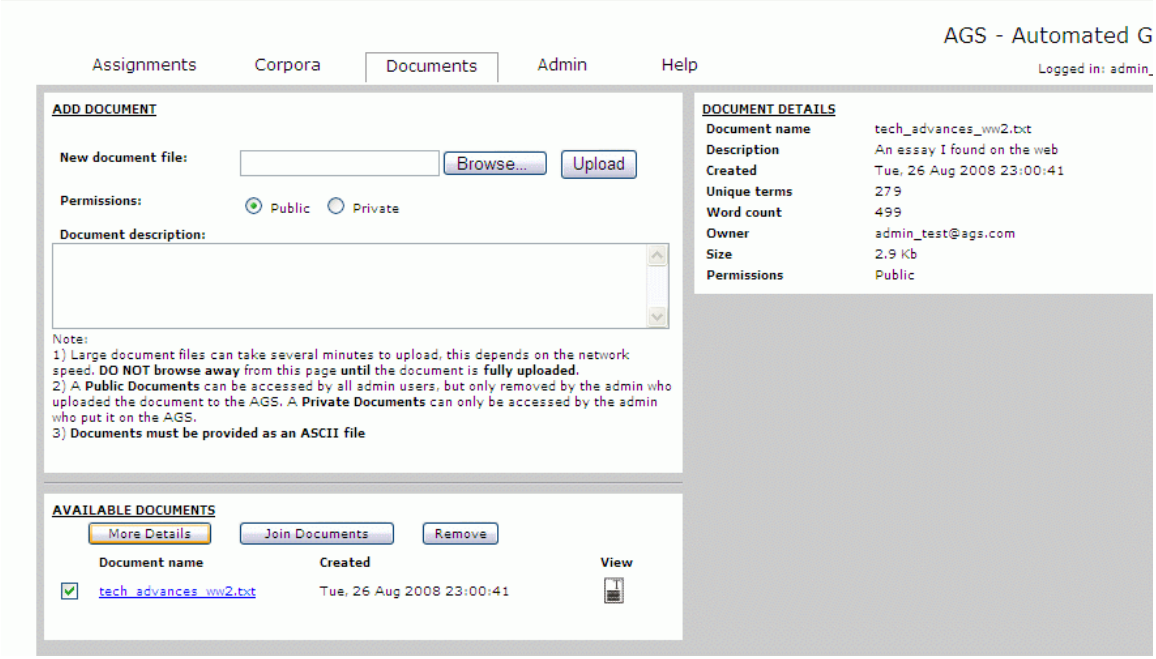

Figure 8 AGS Documents Page – More Details

2.1.5 Assignments

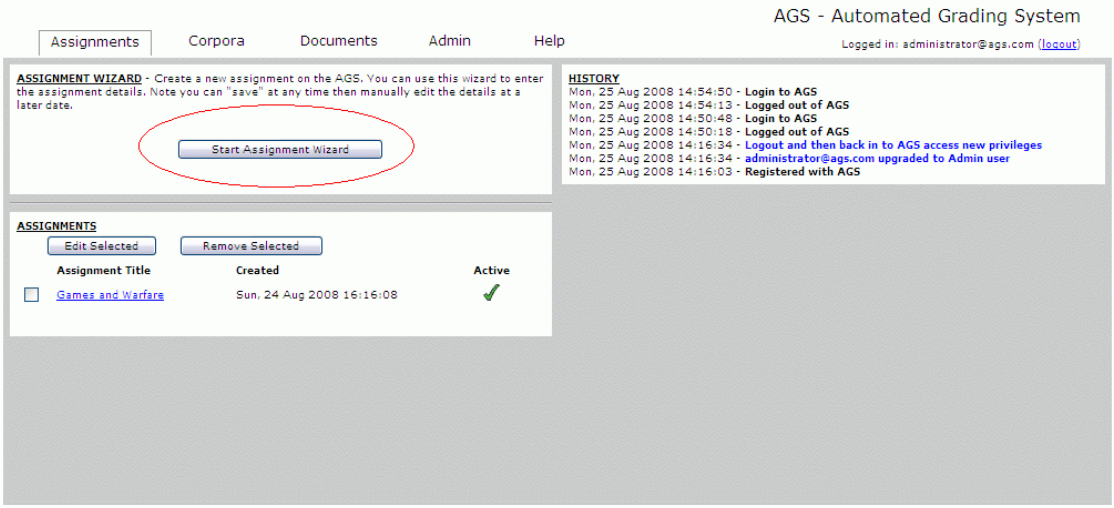

Figure 9 Creating a new assignment with the Assignment Wizard

2.1.5.1 Creating a New Assignment

After the necessary assignment documents and corpus have been loaded onto the AGS (see Corpora and Documents sections above), the instructor can use the Assignment Wizard to create a new assignment. Click on the "Assignments" tab of the top main menu to see Assignments page displayed in Figure 9. In the top-left box labeled "ASSIGNMENT WIZARD", click on the "Start Assignment Wizard" button to open the Assignment Wizard.

Note: At each stage of the assignment creation process the Assignment Wizard will prompt the instructor for information about the assignment. A description of the information required by the AGS and addition tips are also displayed on the screenshot (circled in red in Figure 10).

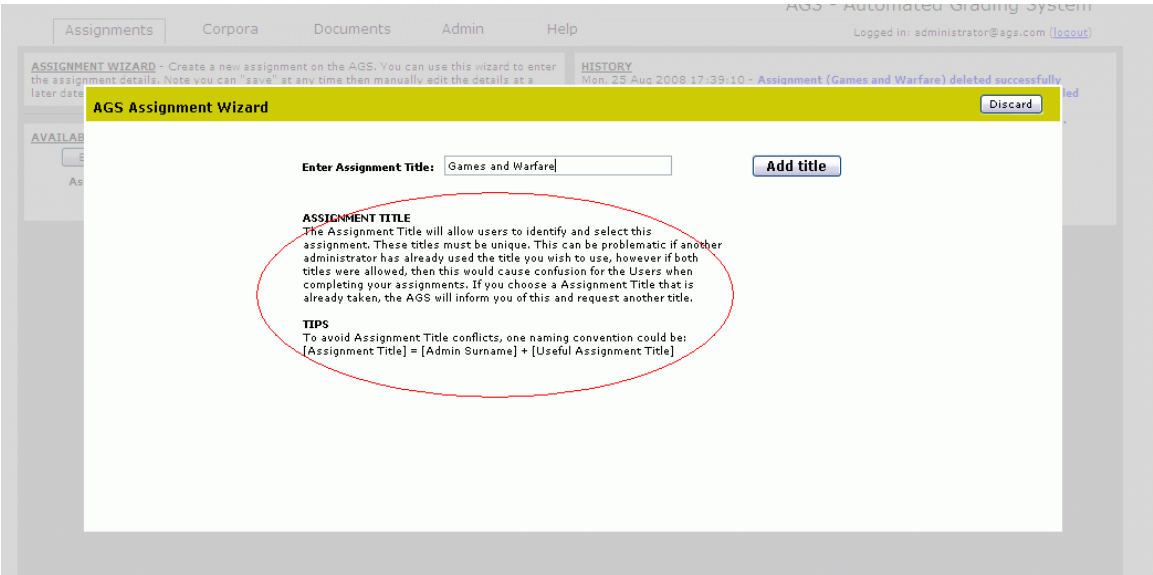

Figure 10 The Assignment Wizard

2.1.5.2 Assignment Summary Page

After the instructor has completed filling in the assignment information that the Assignment Wizard requested, an Assignment Summary is displayed (see Figure 11). From this screen the instructor can:

1) Activate the Assignment – only Active assignments will be accessible to Student Users of the AGS. To make an assignment active click on the "Activate Assignment" button.

2) Edit Assignment components – select an assignment component by clicking the radio button located before its label (e.g. Description), then click on the "Edit Selected" button.

3) Access Student User Results – click on the "View User Results" button.

4) Save personal notes about the Assignment – enter personal notes in the text area located on the right-hand side of the display, then click on the "Save Notes" button.

5) Delete the Assignment – click on the “Delete Assignment” button.

6) Save the Assignment – click on the “Save Assignment” button

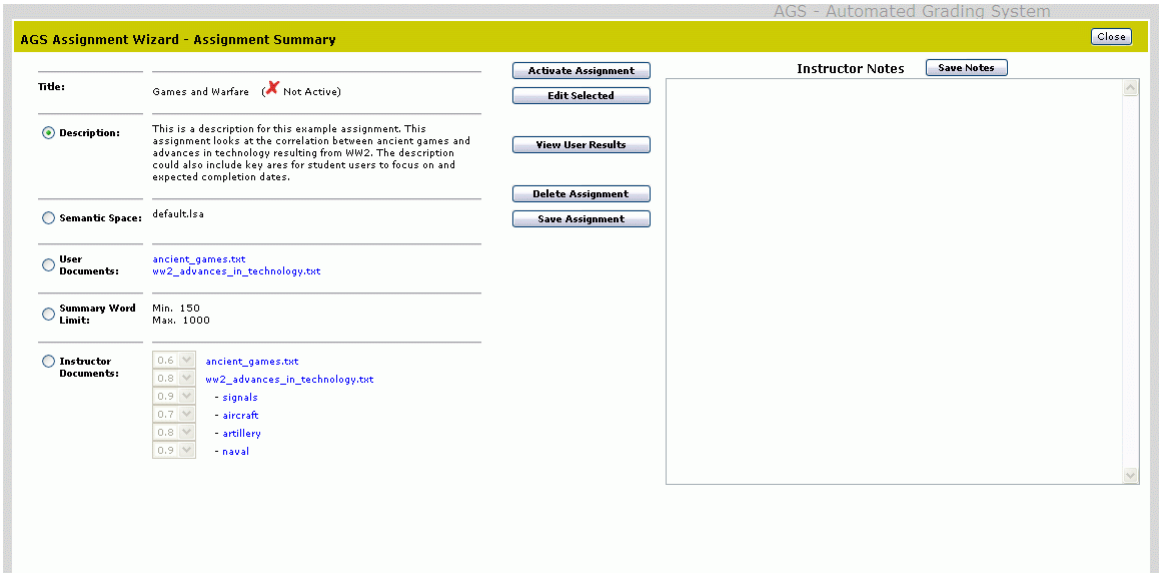

Figure 11 Assignment Wizard – Assignment Summary

2.1.5.3 Student User Results

To pass an assignment the Student User’s summary must score equal to or greater than ALL of the “Pass Cut Off Scores” that have been set by the instructor. As mentioned previously in this manual, the AGS will rate the similarity of the Student Summaries to the Instructor Documents (gold standard summaries) on a scale ranging from 0 (no similarity) to 1 (high similarity). If the Pass Cut Off Score for a particular Instructor Document was set at 0.8 and the similarity score calculated by the AGS between that document and the Student Summary was 0.5, then the user would fail, alternatively a similarity score of 0.8 or greater would pass.

Note: A Student Summary will only pass if it matches or exceeds the Pass CutoOff Scores set by the instructor for ALL Instructor Documents.

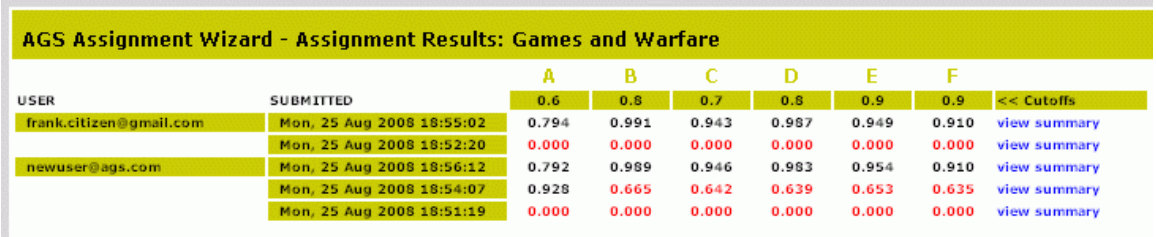

Figure 12 Instructor's Assignment Results Page.

As can be seen on the Assignment Results Page displayed in Figure 12, Student Summaries that did not reach the Instructor Document Pass Cut Off Scores failed (indicated by red text). To the Student User, a fail on any recorded comparison to a Instructor Document would mean an overall fail and they would need to resubmit their Student Summary. The Student User is only given the overall grade PASS or FAIL. To view a Student User's summary in a new window, simply click the "view summary" link.

2.1.5.4 Editing an existing assignment

Assignments that have previously been added to an instructor's profile are displayed in the "Available Assignments" section of the Assignments page (see Figure 13). To edit an assignment listed in this section, either click on the link displaying the assignments name or click on the check-box located before the assignments name and then click on the "Edit Selected" button. The instructor will then be presented with the Assignment's Summary page (see Figure 11).

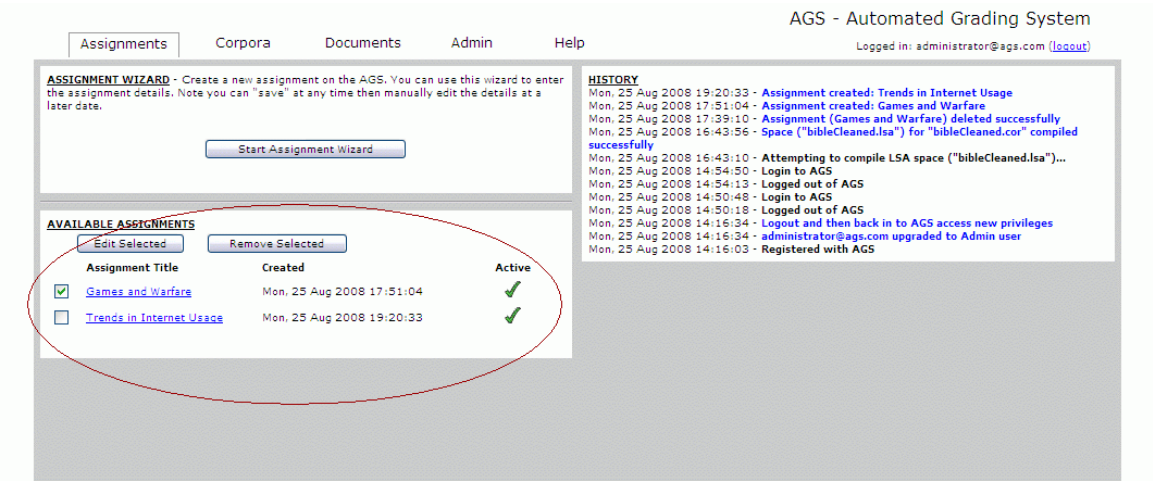

Figure 13 Editing an existing assignment

2.1.5.5 Removing an existing assignment

To remove an assignment from the AGS, on the Assignments page in the "AVAILABLE ASSIGNMENTS" section, select the check-box located before the assignment, and then click "Remove Selected". This will completely delete the Assignment from the AGS, which will not be recoverable. However, both the documents, corpus files and Spaces used in this assignment will still be available to the instructor on the AGS system.

2.1.6 Editing Administrator Details

2.1.6.1 Changing your administrator user password

The AGS offer the admin user the ability to change their current password. First click on the "Admin" menu tab at the top of AGS interface page. In the top-left box of the Admin page (see Figure 14), "admin user details" such as first name, surname, email address and star-hidden password are display. Next to the star-hidden password is a button labeled "Change". Clicking on the "Change" button displays a form that request the admin user to input both their old password and a new password. After entering these details, click "Submit" to change the admin user's password.

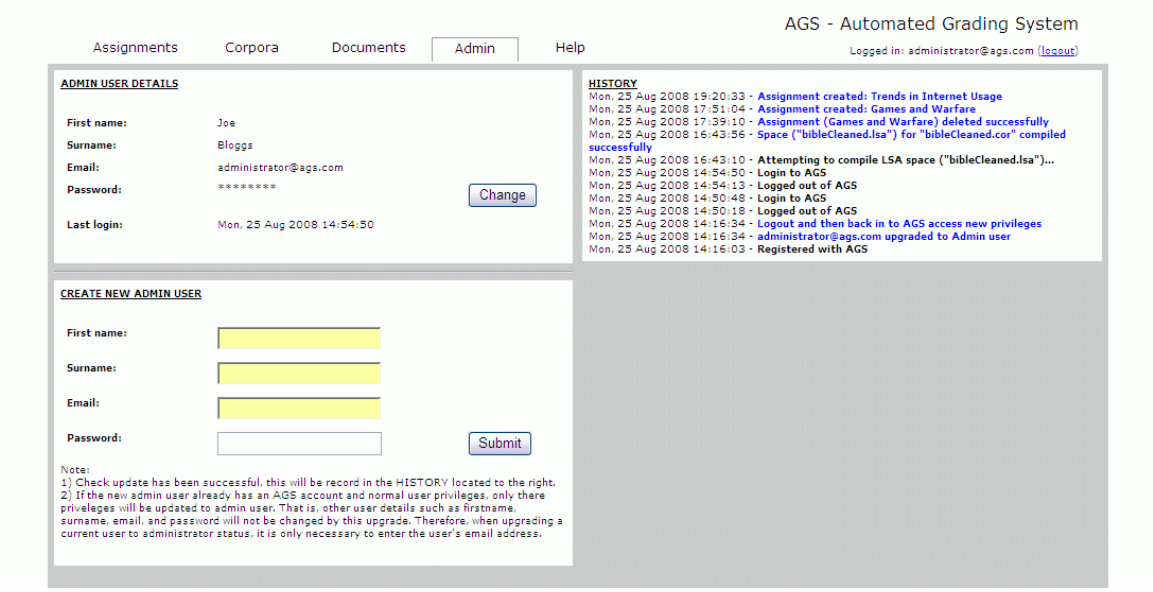

Figure 14 Create a new admin user.

2.1.6.2 Creating a new administrator user

Admin users can both create new admin users and upgrade existing student users to admin users. To create a new admin user, fill in the new admin user's details in the box labeled "Create New Admin User" located in the bottom-left of the Admin page (see Figure 14). Then click submit, and the new admin user will be able to login to the AGS with these details. To upgrade an existing student user to the level of admin user, it is not necessary to enter all of the user's details

in the “Create New User” box, only the email address they use on the AGS. Then click submit. The next time the student user logs into the AGS they will have admin user privileges. Note entering any other details for the student user in this box will not change these details on their AGS profile, only their status will be upgraded to admin user by this action.

3 Validation Study for the AGS

3.1 Background

The purpose of this study was to measure the extent to which the AGS improves the quality of INTSUMs, and the extent to which the AGS's assessment of the INTSUM quality was aligned with a human's assessment of the documents. For the experiment reported here, human grades were provided by the lead instructor at CFSMI.

3.2 Method

3.2.1 Participants

Twenty-one undergraduate students at Ohio State University participated for course credit. Age and demographic information was not collected.

3.2.2 Materials

3.2.2.1 Training Materials for the AGS

The first step for AGS is to provide it with a sample of language from which it will create semantic representations for terms. For the exercise reported here, the LSA component of the AGS was trained on approximately 10,000 articles scraped from the Stratfor geo-intelligence website. The AGS was also provided with a so-called "join list" which contained the names of cities, regions, countries, continents, and other parts of the world with multiple terms in their names (e.g., North America). The purpose of the join list is to ensure that the LSA component of the AGS treats *North America* as a single object with a semantic representation rather than creating a semantic representation for both component terms, *North* and *America*.

3.2.2.2 Materials shown to participants

Eight newspaper articles on the topic of maritime piracy were selected from the open source media for summarization by participants. The shortest article had 123 words, and the longest had 867 words. The articles used in the experiment are not reproduced here but can be made available upon request.

3.2.2.3 Materials not shown to participants

A Summary article was written by the lead instructor at CFSMI to serve as the gold standard against which all summaries written by participants would be compared. The gold standard document read as follows:

During the summary period, seven vessels were reported hijacked, with an attempt made on at least two others. Two vessels were reported as released. The Somali pirates currently detain at least six vessels and 132 sailors.

On 12 June 2009, a German-owned cargo ship was seized off the coast of Oman, the first recorded attack in its territorial waters. On Oct. 19 the Chinese bulk carrier, the De Xin Hai, was hijacked north of the Seychelles. The 41,000 metric ton vessel is carrying about 76,000 tons of coal. On Monday 16 Nov the chemical tanker MV Theresa with 28 North Koreans on board was hijacked. In a second incident the same day, pirates attacked a Ukrainian cargo ship. Private security guards on board returned fire, wounding two. EU says the Ukrainian ship was not hijacked, though a possible pirate spokesman claims that it was. The Greek-owned 300,000-ton Maran Centaurus was seized on 29 Nov 2009 about 800 miles off the coast of Somalia. It was carrying a cargo of crude oil and 28 crew members. The British-owned yacht, the Lynn Rival, was seized in the Indian Ocean on 23 October. Somali pirates are demanding a 4m ransom for the release of the crew, British couple Paul and Rachel Chandle.

This year, Somali pirates hijacked the 4800 ton North Korean cargo ship MV Rim early Feb. 3 in the Gulf of Aden. The ship was traveling outside the normal transit corridor with unknown cargo and was not communicating with maritime authorities. If the cargo is weapons or drugs, which North Korea has been known to ship to other countries, it may be seized and used by pirates in lieu of ransom demands. On 4 March 2010, according to AFP, the 2,100-tonne Spanish vessel Albacan, fishing half way between the Seychelles and the Kenyan coast, was attacked by pirates in the Indian Ocean. It was approached by two pirate skiffs, one of which fired a rocket-propelled grenade that exploded on the deck of the fishing vessel. "Private security armed guards" fired back "over the heads of the pirate skiff" and the attackers fled. On Mar 4 an empty Jeddah-bound Saudi oil tanker, the Al-Nisr Al-Saudi was hijacked resulting in a $20 million ransom demand for the 5136 ton vessel and its crew of 13. The ship is believed to be moored near Garacad, Somalia. The tanker was reportedly outside an internationally recognized transit corridor. In an undated incident reported by Arab News, a Turkish vessel escaped capture due to the intervention of a Saudi patrolling team.

Somali pirates released the Italian-flagged tugboat Buccaneer Aug. 10 2009. Although the Italian government denies ransom payment, pirates claimed to have received between $4 and $5 million. Pirates also freed the German vessel Hansa Stavanger and its crew Aug. 3 2009 after a ransom of $2.7 million was paid. Both vessels were seized in early April 2009

In addition to the gold standard, the experimenters included four gold "nuggets". Each nugget represents a segment of text containing information that a good summary must have. Each nugget has an associated "hint" that participants read to find out what kind of detail might be missing from their summary. The need for having nuggets is not obvious, but they are important because the evaluation of the quality of a summary is based on the semantic similarity between it and the gold standard documents. That being the case, it is possible that a summary can miss important details and still have high semantic similarity to the gold standard. Measuring the summaries' similarity to the nuggets allowed the instructor to determine the extent to which important pieces of information were also present in the summary. The hints and nuggets were was follows:

Hint 1 : **What was the nationality of the pirates?**

Nugget 1: Somalia officially the Somali Republic (Somali) and formerly known as the Somali Democratic Republic under Socialist rule, is a country located in the Horn of Africa. Since the outbreak of the Somali Civil War in 1991 there has been no central government control over most of the country's territory. Somalia has a population of around 10 million inhabitants. About 85% are ethnic Somalis, who are traditionally nomadic pastoralists and have historically inhabited the northern part of the country

Note: The text of Nugget 1 was copied from Somalia's entry in Wikipedia

Hint 2: ***What are the nationalities of the ships that were hijacked?***

Nugget 2: Europe Asia European Asian German Germany words Chinese China North Korea North Korean Ukranian Ukraine Greek Greece British Britain England English UK United Kingdom Spanish Spain Turkish Turkey Italian Italy

Hint 3: ***Where did the hijackings occur?***

Nugget 3: Oman, officially called the Sultanate of Oman is an Arab state in southwest Asia on the southeast coast of the Arabian Peninsula Oman Seychelles. Indian Ocean Aden is a seaport city in Yemen, located by the eastern approach to the Red Sea the Gulf of Aden, some 170 kilometres east of Bab-el-Mandeb. Aden was the capital of the People's Democratic Republic of Yemen until that country's unification with the Yemen Arab Republic

Note: The text of Nugget 3 was copied from Oman's entry in Wikipedia

Hint 4: ***What were the conditions of release?***

Ransom is the practice of holding a prisoner or prisoners or item to extort money or property to secure their release or it can refer to the sum of money involved. A consideration paid or demanded for the release of someone or something from captivity

Note: The text of Nugget 4 was copied from *Ransom*'s entry in Wikipedia

3.2.2.4 Experimental Apparatus

The experiment was run on personal computers running a web-browser, and connected to the internet. The AGS was installed on a server at Ohio State University.

3.2.3 Procedure

3.2.3.1 Data Collection

Participants were tested in groups, but worked individually. Each participant had his or her own computer on which to work, and was given a user account in the AGS. After a brief instruction session on how to use the AGS, they logged on, and did the task. Each participant read the eight newspaper articles, and wrote a summary inside a text window contained in the AGS. After completing the summary, the participant clicked on a button labelled, "submit summary" and was

immediately provided feedback on the quality of their summary. Feedback came in the form of a set of five cosines, one for the summary's similarity to the gold standard and one for each of the hints. Participants were asked to edit their summaries as much as and as many times as required to maximize the five cosines, and to stop when they were satisfied that they could not be improved further.

3.2.3.2 Grading of Summaries

Summaries were graded using two means. They were graded by the AGS via the LSA module and by the lead instructor at CFSMI. For each participant, two summaries were graded: the summary written on the participant's first attempt and the participant's final submission after they had used the feedback to improve it. The AGS provided five scores for each of the two summaries submitted by participants. The scores were taken as the vector cosine between the summary and the gold standard, and to each of the four nuggets we included.

The summaries were then sent to the lead instructor at CFSMI for grading. The instructor was given the 21 pairs of summaries (2 summaries from each participant) in a single file. Which summary was written first or last was randomized for each of the 21 pairs. The instructor was asked to grade each summary on a 10-point scale where, a score of 10 represented a perfect summary and a score of 1 represented an exceptionally poor quality one.

3.3 Results and Discussion

We will organize this section of the report into a set of questions that we can ask regarding how well the AGS improved INTSUM creation.

3.3.1 Were the grades given by the AGS and the instructor generally in agreement?

There was a modest but reliable relationship between the AGS and the instructor for grades given to essays written on the participants' first attempt, $r = .42$, $t(20) = 2.03$, $p < .05$. In other words, generally speaking, the instructor and the AGS agreed upon what were good and poor initial attempts at writing an INTSUM. The agreement between the two sources of grades dropped for the final summary submission, $r = .17$, $t(20) = 0.75$, $p > 05$. The drop in agreement is not surprising—a strong correlation requires a healthy amount of variability in the grades being compared. As all the INTSUMs improved with practise, the variability in the grades decreased, thus reducing the relationship between grade sources.

3.3.2 Did the AGS and the instructor agree that INTSUMs got better with practice?

Yes. Virtually all participants' INTSUMS improved with practice. Importantly, the improvement was noted by both the AGS and the instructor. Vector cosines comparing summaries written before training to the gold standard ($M = .94$) were consistently lower than the cosines for those summaries written after training ($M = .95$), $t(20) = 3.62$, $p < .01$. As well, the instructor's average

grade out of 10 for summaries written before practice was lower ($\underline{M}$ = 3.8) than that for those written after practice and feedback ($\underline{M}$ = 4.9), $t(20) = 5.16$, $\underline{p} < .01$.

To measure the degree of agreement, we calculated a Spearman's rank correlation, or Rho, between the improved grades noted by both for every participant. The Spearman's rank correlation basically measures the extent to which big the AGS and instructor agreed on which participants experienced large improvements in their INTSUM quality and which had only little. Across the 21 participants, the Spearman correlation was strong, $\underline{\rho} = .58$. Hence, the AGS and instructor also agreed upon the amount of improvement that participants had as a result of training and feedback.

3.3.3 Did the amount of improvement depend on the amount of practice participants had?

No. There was no reliable relationship between the number of INTSUM iterations participants went through before submitting and the final grade they received from either the instructor or AGS. In other words, while practice had a significant effect on the quality of the INTSUMs, the amount of practice seemed to matter very little.

4 Conclusions and Recommendations

The AGS was developed jointly by DRDC and CFSMI to provide the school with an easy means by which students could improve summary-writing skills without the need for in-class instruction. It is a simple-to-use, browser-based tool that allows students to practice their writing ability on any computer connected to the network upon which the tool is installed. We have included the user's manual for students in the appendix of this report.

The small validation study reported above establishes that the AGS is an effective tool for improving the quality of INTSUMs—both the AGS and human grader agreed that the participants' summaries improved after feedback. Because the AGS appears to be an effective tool for improving summary/report quality, we recommend that it be considered for inclusion in of a suite of educational tools for Canadian Forces members enrolled in programs that require effective writing skills from its graduates.

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Annex A AGS Student User Manual

Automated Grading System (AGS) – Student User Manual

The Automated Grading System uses Semantic Models that generate estimates of similarity for pairs of documents. In this way, the AGS can compare and mark student summaries against a "Gold Standard" summary written by an instructor. The semantic models need to be trained on a document set or corpus that contains the background knowledge for a given summary topic. This background knowledge is required so that the AGS can make accurate comparisons between the student and instructor summaries given a certain topic. In summary, it is possible to use the semantic models contained in the AGS system to grade student summaries and provide immediate feedback to the student user.

System Requirements

As a student user of the AGS, system requirements are minimal. The AGS is a web based application works well with the major PC web browsers: Internet Explorer (v.6+), Firefox (2.0.0.6+) and Opera (9.10+). For best display, it is recommended that the student user utilizes the most current version of the web browser. The AGS system requires that both JavaScript and pop-ups be allowed for the AGS website on the student user's web browser.

Getting Started with the AGS

On the right-hand side of the login page (Figure 1) there is a registration box for new student users. Simply, fill in your first name, surname, email address, and choose a password. After registration is complete you will be logged into the AGS. To log back in on subsequent occasions use the login box on the left-hand side of the main page using your email address and password.

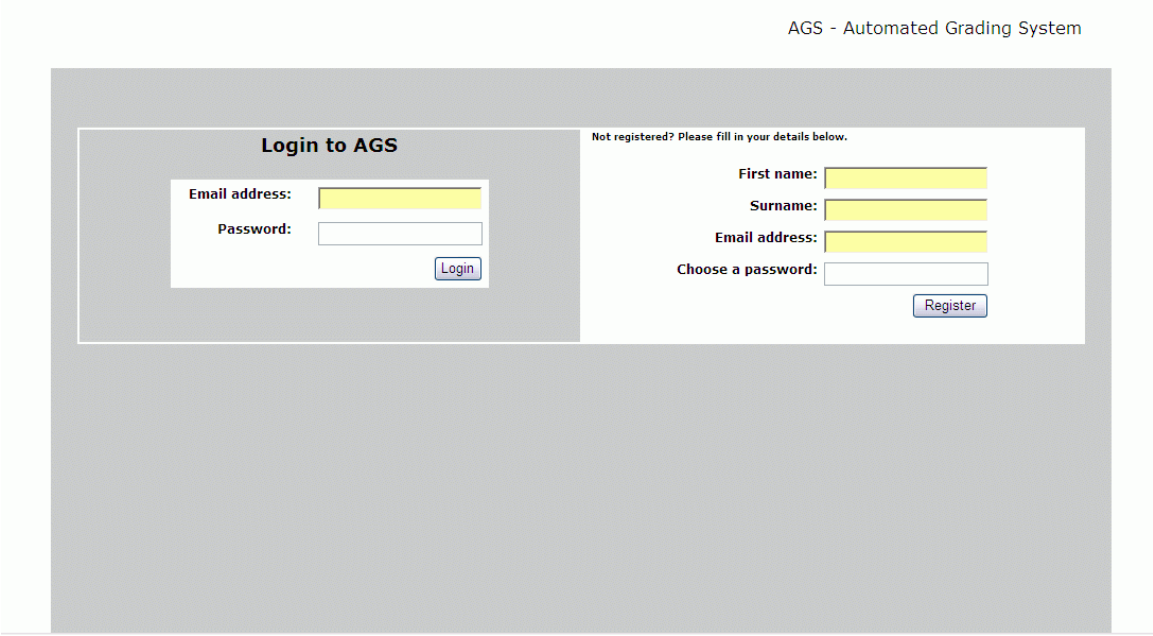

Figure 15 AGS login page.

Finding your way around
As a student user of the AGS system you have access to the Assignments, User Details, and Help Sections. These sections are accessed by clicking on the tabs at the top of the user interface (Figure 2). These sections will be described below in more detail. To logout of the AGS at any time, click the "logout" link underneath the AGS logo on the top right of the page.

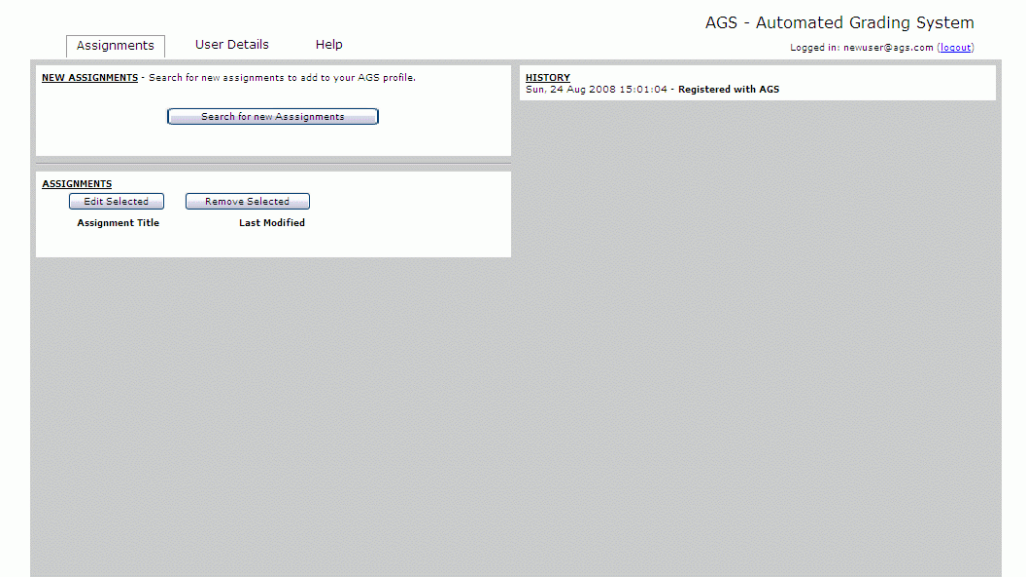

Figure 16 AGS user interface (Assignments Page

New Assignments
To search for new assignments to add to you AGS profile, click "Search for new Assignments" button situated in the top left box of the Assignments page (see Figure 2). A new screen will appear (see Figure 3), that contains a drop down menu that allows the student user to browse through the active assignments that have been set by instructors. To help find a particular assignment, instructor names have been included with assignment names in this drop down menu. After selecting an assignment from the drop down menu, click the "Select Assignment" button to access the assignment

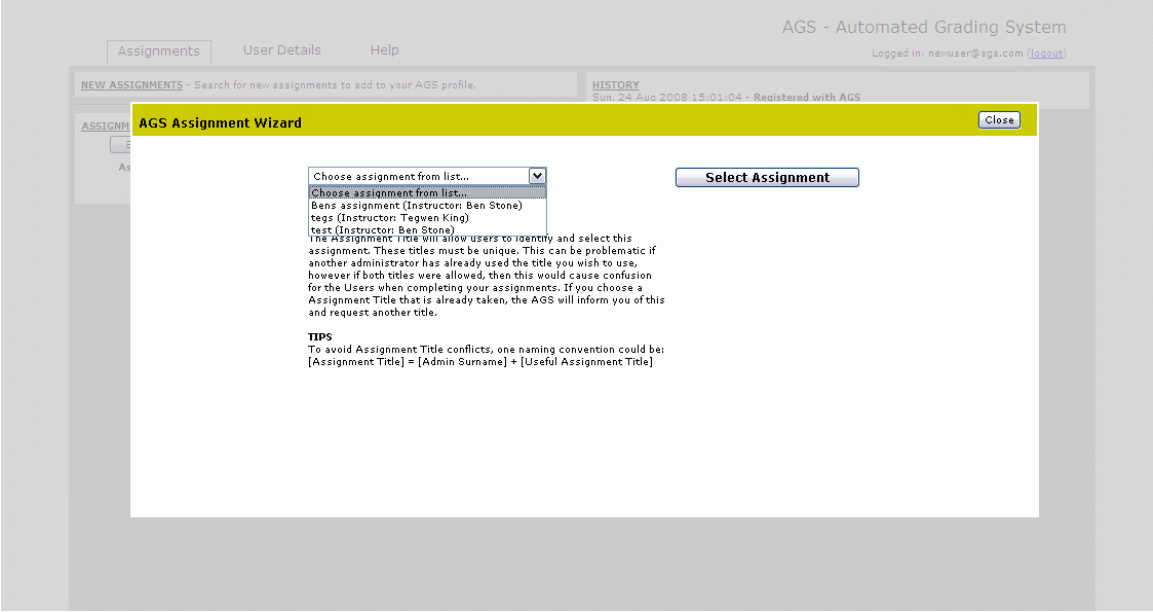

Figure 17 Finding a new Assignment

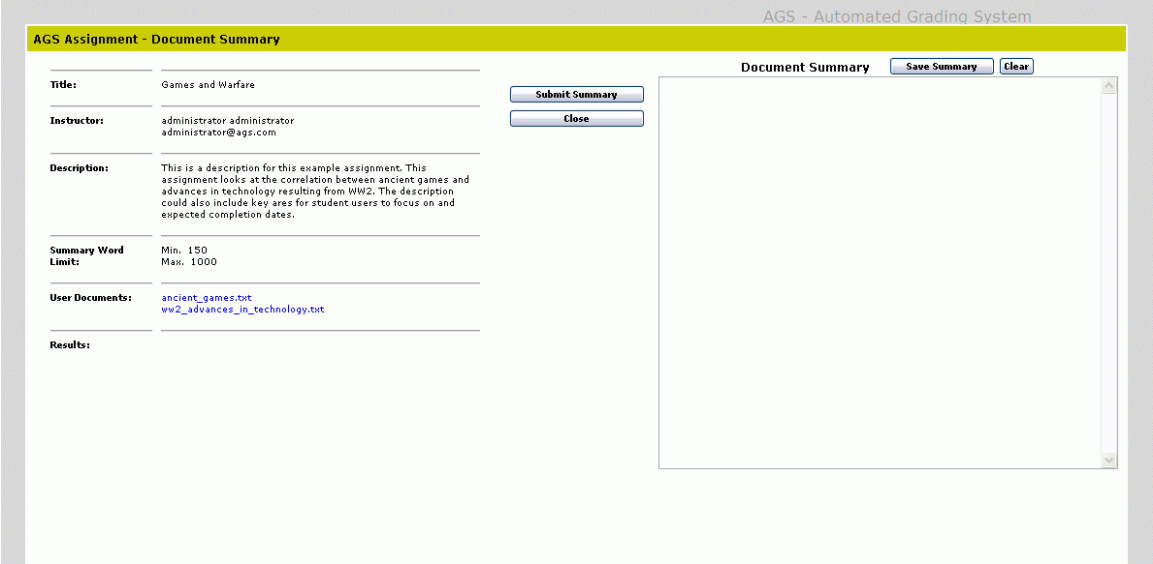

Figure 18 Assignment - Document Summary page

Assignments

After selecting a new assignment (as described in the previous section) the student user will be presented with the "Assignment - Document Summary" page (see Figure 4). This is the work page for this assignment. It contains all the information supplied to the student user by the instructor who created this assignment. This information includes: Assignment Title, Instructor Details, Assignment Description, Instructor selected User Documents to Summarize, Student User Summary Word length constraints, and Results of previous submissions for this assignment.

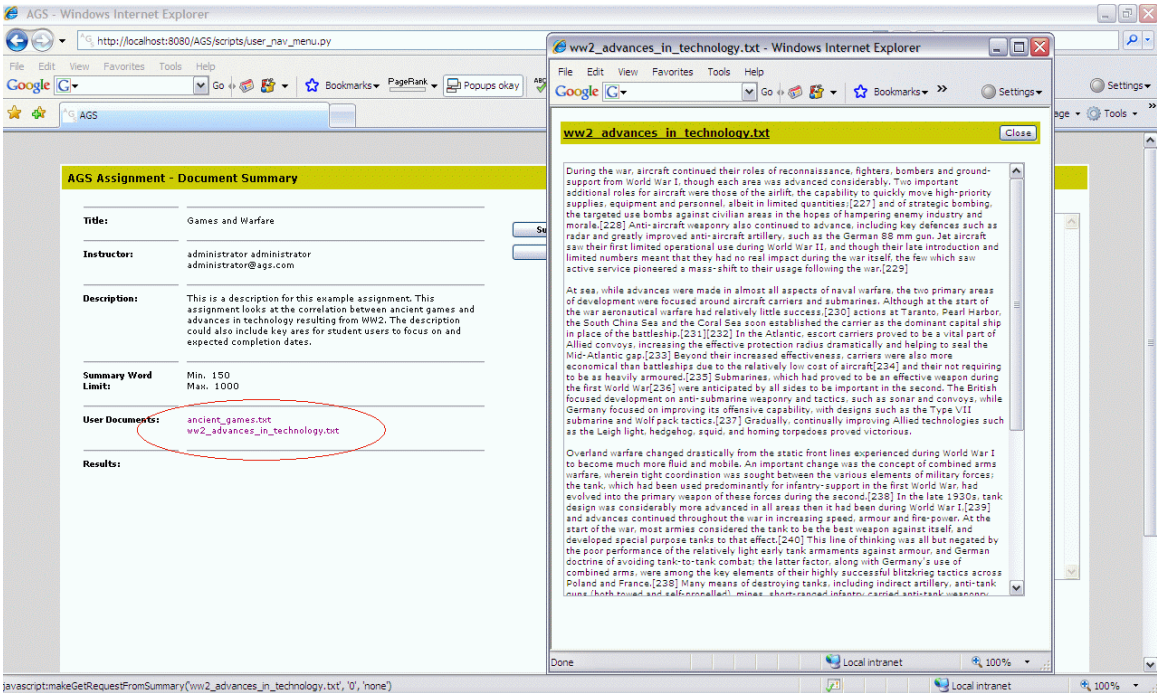

Figure 19 Instructor supplied User Documents for students to summarize.

User Documents

User documents are supplied by the instructor for students to summarize for each assignment. The student user can access these documents by clicking on the links contained in the "User Documents" section of the "Assignment – Document Summary" page. By clicking these User Document links, a new browser window is opened containing the corresponding document (see Figure 5) . *NOTE: Pop-up windows must be allowed for the AGS website in you browser settings to enable these documents to be display.*

Saving a Summary

The student user can save a working copy of the current summary to the AGS system clipboard by clicking the "Save Summary" button located above the text area on the right-hand side of the "Assignment – Document Summary" page. Saved assignments ARE NOT automatically submitted for grading. Instead they are kept in the text area for the student user to continue using at a later date. *Note: A Summary first be saved by clicking "Save Summary", before it can be submitted by clicking "Submit Summary".*

Submitting a Summary

The Student's Summary of the User Documents is entered into the "Document Summary" text area on the right-hand side of the "Assignment -Document Summary" page (see Figure 6). After the student user has typed the summary (or copying and pasting from another document) into this text area and clicked "Save Summary", she can then click the "Submit Summary" button located in the center of the page to have it graded by the AGS system. After grading the summary, a PASS/FAIL grade will then be display next to a link to a copy of this summary in the "Results" section on the left-hand side bottom of the "Assignment – Document Summary" page. Previously submitted Student Summaries in the Results section can be viewed by clicking on the links in this section. Most recently submitted Student Summaries will be displayed at the top of the Results section.

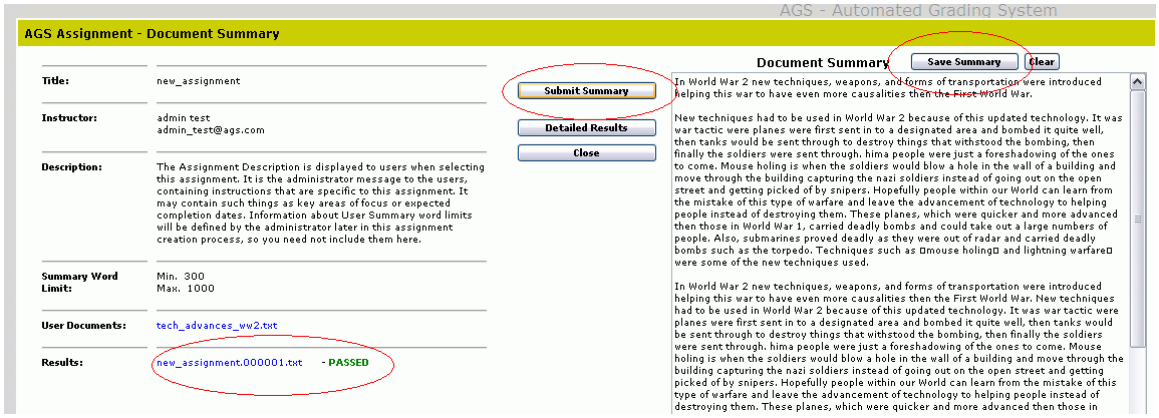

Figure 20 Submitting a summary for grading

Clearing a Summary

Clicking on the "Clear" button located above the text area will remove the text contained in the "Document Summary" text area from the page and from the AGS system clipboard.

Closing an Assignment

To close an assignment, simply click the "Close" button located in the center of the "Assignment – Document Summary" page.

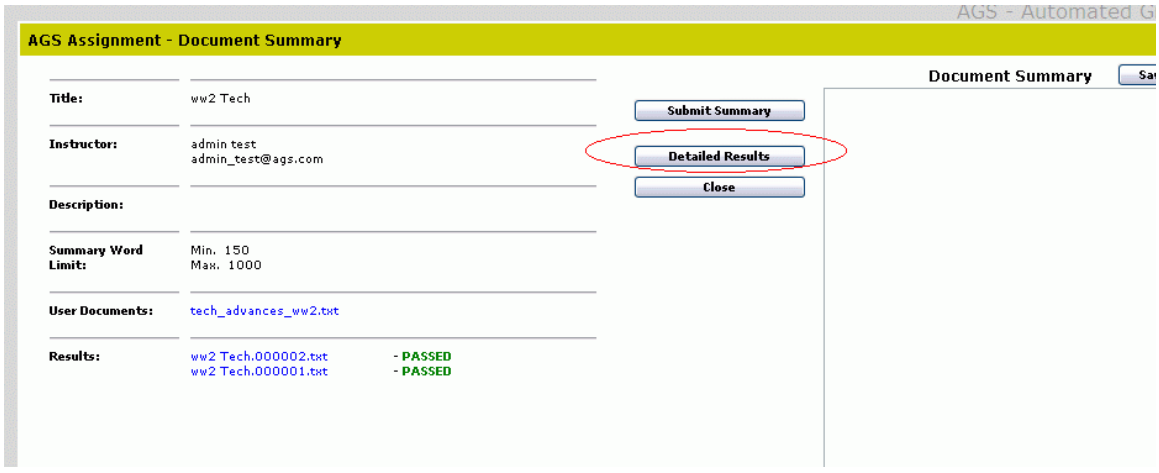

Figure 21 Accessing Result Details

Detailed Results

The Student User can access a detailed breakdown of how their summary was marked against the requirements of the instructor. To do this click the "Detailed Results" button located in the middle of the "Assignment – Document Summary" page (see Figure 7). The Assignment Results page will then be displayed to the Student User (see Figure 8). On the Assignment results page, a breakdown is given on how each summary submitted for a particular Assignment was graded against the Instructor's criterion. The Student User's summary must exceed the cutoff scores set by the Instructor on all criteria to PASS. All scores range between 0 (lowest) and 1 (highest). An indication of the topics on which these criteria are based is given under the "HINTS" section located on the right-hand side of the Assignment Results page (see Figure 8). Summaries can be view by clicking the "view summary" links on this page.

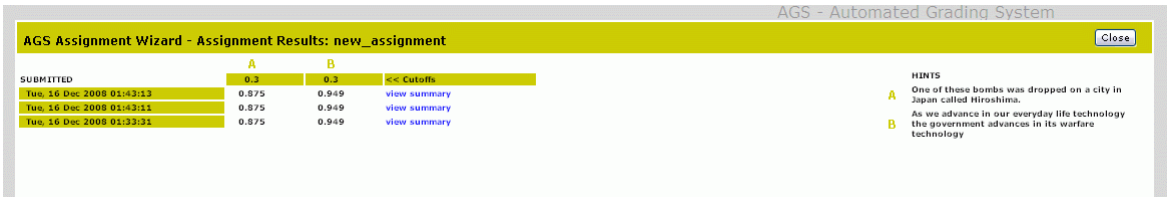

Figure 22 Assignment Results

Opening an existing assignment

Assignment that have been previously been added to a student user's profile are displayed in the "Active Assignments" section of the "Assignments" page (see Figure 9). To open an assignment listed in this section, either click on the link displaying the assignments name, or click on the check-box located before the assignments name and then click on the "Open Selected" button.

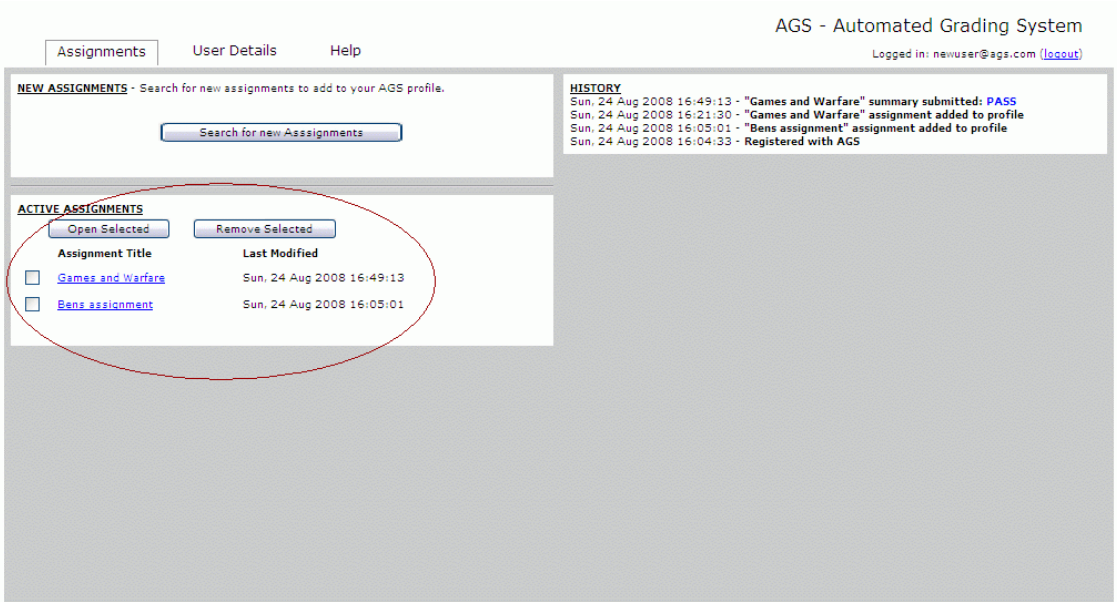

Figure 23 Opening and removing existing assignments

Removing an existing assignment
To remove an assignment from the Active Assignments listed on the Assignments page, select the check-box located before the assignment and then click “Remove Selected”. Removing an assignment only deactivates it on the student user’s profile, it does not delete the assignment or the work previously completed by the student on this assignment from the AGS. To re-activate an assignment that has been removed, select it again from the assignment list which is displayed when searching for a new assignment (see “New Assignments” section above).

User Details Section

Changing your password
The AGS offer the student user the ability to change their current password. First click on the User Details menu tab at the top of AGS interface page. User details such as firstname, surname, email address and star-hidden password are display. Next to the star-hidden password is a button labeled “Change”. Clicking on the “Change” button displays a form that request the student user to input both their old password and a new password. After filling in these details, click “Submit” to change the student user’s password.

Help Section

The “Help” section of the student users AGS interface contains a copy of this document..

List of symbols/abbreviations/acronyms/initialisms

DND	Department of National Defence
DRDC	Defence Research & Development Canada
AGS	Automated Grading System
LSA	Latent Semantic Analysis
CFSMI	Canadian Forces School of Military Intelligence
R&D	Research & Development
CDA	Canadian Defence Academy
IATF	Influence Activities Task Force
RMCC	Royal Military College of Canada

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Users' Manual and Validation of the Automated Grading System (AGS): Improving the Quality of Intelligence Summaries Using Feedback from an Unsupervised Model of Semantics

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The Automated Grading System (AGS) was developed jointly by Defence Research and Development Canada (DRDC) Toronto and the Canadian Forces School of Military Intelligence (CFSMI) to provide students at the school a tool to help in the composition of accurate and effective Intelligence Summaries (INTSUMs). The AGS is a web-browser based system that provides feedback to students about how well their summary matches that of a gold standard summary written by an instructor. The AGS allows students to iteratively correct and re-submit their summaries as they attempt to maximize the match between their summary and the gold standard. In this report, we provide both the instructor and student user's manual for the AGS. Importantly, we also provide the results of a small validation study wherein we asked participants to summarize news stories about sea piracy near Somalia. Participants used feedback from the AGS to improve their summaries until they were satisfied that they had done the best job they could do. The grades given to the first and final summaries by the AGS were then compared to the grades awarded by the lead instructor at CFSMI. The tool and the instructor's assessments of the summaries were in close agreement. The results confirm that the AGS can be used as an effective teaching tool to help students improve their summary-writing skills.

Le système automatique de notation (AGS) a été développé en collaboration avec Recherche et développement pour la défense Canada (RDDC), à Toronto, et l'École du renseignement militaire des Forces canadiennes (ERMFC) dans le but d'aider les élèves à rédiger des résumés renseignement (INTSUM) efficaces et précis. Il s'agit d'un logiciel Web permettant aux élèves de savoir dans quelle mesure leurs résumés correspondent au modèle idéal composé par un instructeur. L'AGS leur permet de modifier itérativement leurs textes et de les faire analyser de nouveau pour maximiser la correspondance. Ce rapport comprend un manuel d'utilisateur pour les instructeurs et les élèves. Il présente également les résultats d'une petite étude de validation durant laquelle les participants ont résumé des reportages sur la piraterie en mer près de la Somalie. Ils ont utilisé la rétroaction de l'AGS pour retravailler leurs compositions jusqu'à ce qu'ils jugent avoir fait de leur mieux. Les notes attribuées par le logiciel pour les premiers et derniers résumés ont été comparées à celles données par l'instructeur principal de l'ERMFC, et le tout concordait. Cela confirme que l'AGS est un outil pédagogique efficace pouvant aider les élèves à améliorer leur capacité à rédiger des résumés.

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summary writing; tutor; automated grading

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